- Drinking, culinary, and food processing water supply;
- agriculture water supply;
- aquaculture water supply, and;
- contact recreation, with the exception of wading

II. Criteria to Protect the Designated Uses

The criterion for industrial water supply is a narrative criterion that states that substances that pose hazards to worker contact may not be present. A review of the available literature indicates that criteria to protect workers have not been developed for cadmium (EPA Quality Criteria for Water, 1976).

The Table at 18 AAC 70.230(e)(18) states that the Main Stem Red Dog Creek is protected for contact recreation, wading only. However the definition section at 18 AAC 70.990(16) defines contact recreation to "not include wading". Due to the cold temperature and the natural condition exceeding the Drinking Water MCL for Cadmium, the direct and intimate contact recreation uses including swimming, diving, and water skiing are not protected, but wading with rubber boots for activities including water quality sampling is protected. The applicable cadmium criterion for contact recreation (wading only) and secondary recreation is a narrative criterion: "Concentrations of substances that pose hazards to incidental human contact may not be present".

The most stringent cadmium criteria for the Main Stem Red Dog Creek, and Ikalukrok Creek below Red Dog Creek are associated with the aquatic life use designation. There are two types of criteria for the protection of aquatic life: acute and chronic. Acute criteria protect against short term deleterious effects to aquatic life, and chronic criteria protect against long term deleterious effects to aquatic life. For Alaska, the acute criterion for cadmium is a hardness-based criterion that is found in 18 AAC 70.020(b)(11)(C). The acute criterion for cadmium is 5.09 μg/L dissolved concentration, based on the site's ambient hardness of 260 mg/L. The chronic criterion for cadmium is 0.48 μg/L dissolved concentration, based on the site's ambient hardness of 260 mg/L.

Natural Condition Determination

As part of the development of the Use Attainability Analysis (UAA) for reclassification of waterbodies in the vicinity of Red Dog mine, EPA requested information regarding any human activities (land disturbance from road building, camp construction, or exploration) that could have contributed to the water quality exceedences that were found in the pre-mining water quality data base. The UAA concludes that there were no human activities in the vicinity of the mine that could have caused significant changes in the water quality until overburden was removed in the spring of 1987. In accordance with 18 AAC 70.990(41) there were no anthropogenic sources of pollution and the baseline water quality (1981 - 1987) is representative of natural conditions.

Demonstration that the Natural Condition is of Lower Quality than the Applicable Criteria

The waters of Red Dog Creek are atypical of most undeveloped Arctic streams because of the high concentrations of cadmium, lead, and zinc that enter the Middle Fork of Red Dog Creek as it flows through a highly mineralized ore body. The unique character of the Red Dog mineralization and its interaction with ground and surface waters was recognized in scientific studies of the area in the late 1970's and early 1980's (e.g. Ward and Olson 1980). Natural levels of metals were known to be

unusually high, and fish kills (in Main Stem Red Dog Creek) were documented. From 1981 through 1984, Cominco Alaska funded a series of baseline studies to document water quality and biological conditions in Red Dog Creek, Ikalukrok Creek, and the Wulik River (Houghton 1983, Petersen and Nichols 1983). In 1982, ADEC funded a detailed toxicological, biophysical, and chemical assessment of Red Dog Creek (E.V.S. Consultants, Ltd. 1983). In the 1984 Final Environmental Impact Statement (EIS), these studies formed the basis for addressing aquatic and water quality impacts associated with the development of the Red Dog Mine Project.

Water in the Middle Fork Red Dog Creek, beginning adjacent to the highly mineralized orebody, was naturally degraded and remained in this condition downstream to the confluence with the South Fork (L. A. Peterson & Associates, Inc. 1983, Water Quality of Red Dog Creek, Alaska, 1983, in Supplement to Environmental Baseline Studies, Red Dog Project. Dames & Moore report to Cominco Alaska, Inc.). The Middle Fork flowed directly over heavily mineralized rock, and the creek received surface and groundwater draining from the orebody, which contained high metal and sulfide concentrations (U.S. Environmental Protection Agency and U.S. Department of the Interior. 1984. Final EIS, Red Dog Mine Project, Northwest Alaska). Recovery of water quality began at the confluence of the Middle Fork and the South Fork, but was not particularly significant until flow from the North Fork diluted the Middle Fork to form the Main Stem. Pre-disturbance ambient samples collected at station 10 confirm that Main Stem Red Dog Creek had naturally occurring cadmium concentrations above the current water quality criteria. Pre-disturbance ambient samples collected at station 8 confirm that Ikalukrok Creek also had naturally occurring cadmium concentrations above the current water quality criteria.

The dissolved data collected prior to the development of the mine site is summarized in Attachment A-3. In Main Stem Red Dog Creek (station 10) dissolved concentration water quality data were collected from July 23, 1982 through September 3, 1983. At station 10 the cadmium data ranged from a dissolved concentration of 2 µg/L to 41 µg/L. In Ikalukrok Creek (station 8) dissolved concentration water quality data were collected from July 18, 1981 through June 15, 1983. At station 8 the cadmium data ranged from a dissolved concentration of 2 µg/L to 34 µg/L. The 5^{th} percentile of the dissolved data at station 10 is 12.5 µg/L. The 5^{th} percentile of the dissolved data at station 8 is 3.5 µg/L. All of the data collected in these stream segments demonstrate that the water is of lower quality than the cadmium chronic aquatic life criterion of 0.48 µg/L.

The total data collected prior to the development of the mine site is summarized in Attachment A-4. In Main Stem Red Dog Creek (station 10) total concentration water quality data were collected from May 30, 1982 through September 13, 1983. At station 10 the cadmium data ranged from a total concentration of 2 µg/L to 44 µg/L. In Ikalukrok Creek (station 8) total concentration water quality data were collected from May 30, 1982 through August 17, 1987. At station 8 the cadmium data ranged from a total concentration of 1 µg/L to 38 µg/L. The 5^{th} percentile of the total data at station 10 is 9 µg/L. The 5^{th} percentile of the total data at station 8 is 2 µg/L. All of the data collected in these stream segments also demonstrate that the water is of lower quality than the cadmium chronic aquatic life criterion of 0.48 µg/L

Natural Condition Based Site-Specific Criteria Development

The natural levels of cadmium in the ambient waters vary in two ways. First, the cadmium levels decease as the distance downstream from the orebody increases. The cadmium levels are highest in Middle Fork immediately after passing through the orebody, and lowest in the Ikalukrok Creek below

the Main Stem. Ikalukrok Creek below Main Stem represents the highest quality water of those stream segments affected by the orebody. To ensure that cadmium levels in Ikalukrok Creek do not increase above pre-mining levels, this stream segment (station 8) was used to develop the site-specific criterion for Ikalukrok Creek..

Second, the cadmium levels vary over time. The Department's regulation states, in part, that if a natural condition varies with time, the natural condition will be determined to be the prevailing highest quality natural condition measured during an annual, seasonal, or shorter time period. Pre-mining water quality data exist from 1981 to 1987. Water quality monitoring was conducted in 1981 and 1982 in order to establish the pre-mining baseline water quality for use in the EIS that was being prepared before mine development. Additional pre-mining water quality data were gathered in 1983, 1986, and 1987. The 1981 - 1987 pre-mining cadmium concentration data from stations 8 and 10 were used to develop the site specific criterion to ensure that variation in the levels of cadmium from year to year is represented. Some pre-mining data were not used because dissolved cadmium concentrations were not analyzed in those samples. The dissolved cadmium concentration was used to calculate the criteria as required in the Alaska Water Quality Standards (18 AAC 70)[1], however the total cadmium concentration at station 8 was used to calculate the criteria required by EPA for use in setting effluent limits.

To represent the highest quality water, the 5th percentiles of the pre-mining data sets from stations 8 and 10 have been used. The 5th percentiles of the data sets are dissolved cadmium concentrations 3.5 μg/L and 12.5[2] μg/L for stations 8 and 10, respectively, and 2 μg/L and 9 μg/L for stations 8 and 10, respectively. This means that 5 times out of 100 the natural cadmium concentrations were equal to or lower than these numbers (higher water quality) in the respective water bodies. Another way of stating this is that 95 percent of the natural cadmium concentrations were greater than these numbers (lower water quality) in the respective water bodies. Using the Ikalukrok Creek site specific criterion (2 μg/L) means the mine effluent will be required to reflect the highest quality water that naturally occurred in Ikalukrok Creek. Therefore, 95 percent of the time the total cadmium concentration in the mine's effluent will be lower than the total concentration of cadmium in the receiving water. The 5th percentile approach using station 8 data to develop the NCBSSC is a very conservative approach.

The Department believes that the Main Stem Red Dog Creek site specific criterion (12.5 μg/L) is the appropriate criterion to use in calculating effluent limits for the Red Dog Mine facility, however using the Ikalukrok Creek site specific criterion (2 μg/L) is more conservative.

Designated and Existing Use Protection

Federal WQS regulations require that a State specify the water uses to be achieved and protected and there are two broad use categories, designated uses and existing uses. A designated use is a use specified in State WQS regulations for a water body whether or not it is being attained. The designated uses for the waterbodies at the site are listed on page 2 of this appendix: industrial water supply; contact recreation (wading only); secondary recreation; and growth and propagation of fish,

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[1] Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, May 15,2003, Table III; as referenced in 18 AAC 70.020(b)(11)(C).

[2] For sample results that were reported as less than the MDL (generally 25 μg/L); ½ the MDL (12.5 μg/L) was substituted in the dataset for purposes of calculating the 5th percentile. Some results were reported below 25 μg/L; in this case the value reported was used when calculating the 5th percentile.

shellfish, other aquatic life and wildlife. An existing use is, by definition [18 AAC 70.990(24)], "the uses actually attained in a waterbody on or after November 28, 1975."

The Antidegradation Policy requires that existing uses must be protected by a SSC. The Antidegradation Policy states, in part, that "existing water uses and the level of water quality necessary to protect existing uses must be maintained and protected" (18 AAC 70.015(a)(1)).

The following discussion examines whether each designated and existing use could be protected by a site-specific cadmium criteria of 3.5 µg/L and 12.5 µg/L in Ikalukrok Creek and Main Stem Red Dog Creek, respectively. The analysis of designated uses looks at the current and future condition of the waterbodies. For example, is aquatic life currently found at the site or is growth and propagation of aquatic life a future goal for the waterbodies at the site. The time frame for the analysis of an existing use extends from November 28, 1975 to the current time.

I. *Industrial, Contact Recreation (wading only), and Secondary Recreation Uses*

The Red Dog and Ikalukrok Creeks Use Attainability Analysis (UAA) (December 1996) evaluated whether the industrial, contact recreation, and secondary recreation designated uses were existing water uses and whether the designated uses should be retained in the future. The UAA evaluated the "actual" use and the water quality adequate to support the uses. As described in the second paragraph under Section *II. Criteria to Protect the Designated Uses* above, the UAA concluded that contact recreation (wading only) and secondary recreation were existing uses. The proposed site-specific criterion for cadmium of 2 µg/L is not reasonably expected to exceed the narrative criteria for the industrial, contact recreation (wading only), and secondary recreation uses. This expectation considered that the primary Maximum Contaminant Level (MCL) for cadmium is 5 µg/L. Considering the conservative assumptions used in the calculation of an MCL[3] the Department finds that the proposed site specific criteria will not pose a hazard from incidental contact or pose hazards from worker contact. It will therefore, protect these existing and designated uses.

II. *Aquatic Life Use*

Detailed studies were not conducted to document the presence of aquatic invertebrates, macrophytes, or periphyton prior to mining. Limited information is available on benthic invertebrates and fish prior to mine development. Since 1995 studies have been conducted to characterize periphyton and benthic invertebrates. Fish studies have been conducted in the area from 1991 through 2005. A comparison of the aquatic macroinvertebrate and fish communities before and after mine development is summarized in the following paragraphs.[4]

a. *Fish*

Before mine development, Arctic grayling were rarely seen in Main Stem Red Dog Creek and were not reported in Middle Fork Red Dog Creek (Hougton and Hilgert, 1983). Fish were observed in Main Stem Red Dog Creek within the influence of North Fork (Dames and Moore, 1983) and fish mortalities were documented in Main Stem Red Dog Creek (EVS Consultants Ltd., 1983). Before mine development, Arctic

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[3] The MCL is calculated based on the assumption of daily consumption of 2 liters of water containing the MCL throughout lifetime of an average human.

[4] For more information see a report titled: *Comparison of Mainstem Red Dog Creek Pre-Mining and Current Conditions*, Scannell Technical Services, March 1995.

grayling adults were assumed to migrate through Main Stem Red Dog Creek in early spring when discharges were high and metals concentrations low. Outmigration of adults probably occurred during high-water events and young-of-the-year Arctic grayling left as water temperatures cooled in the fall or as they were displaced by high-water events.

After mine development, use of Main Stem Red Dog Creek by Arctic grayling adults and young-of-the-year was higher than that reported during baseline studies in the early 1980s. Stressed or dead fish were not observed. In many cases, adult fish were observed actively feeding on drift and terrestrial insects. Beginning in 1995, juvenile Dolly Varden were caught with minnow traps in Main Stem Red Dog Creek below the North Fork. Juvenile Dolly Varden use of Main Stem has continued to be documented each summer since 1995.

The growth and propagation of fish is an existing use as well as a designated use because fish have occurred in the past and currently use Main Stem Red Dog Creek during the ice free season. Based on the fisheries field work from 1995 through 2005, the fish use of Main Stem Red Dog Creek and Ikalukrok Creek is not diminished compared to the pre-mining fish use.

b. *Aquatic Benthic Macroinvertebrates, and Periphyton*

Aquatic invertebrate communities were sampled by EVS and Ott Water Engineers (1983) and Dames and Moore (1983) as part of the baseline studies conducted for Red Dog Creek. Post mining aquatic invertebrate communities were sampled by the Alaska Department of Fish and Game from 1995 through 2005.

When compared to baseline studies, aquatic invertebrate densities were lower in station 73 in 1995 than in station 73 or station 8 during baseline studies (Red Dog Use Attainability Analysis Aquatic Life Component, February 1996, pp. 31-34). However, these differences likely reflect the fact that the two studies used different methods to collect invertebrates and because invertebrate taxonomy has changed since the baseline sampling.

The growth and propagation of other aquatic life is an existing use as well as a designated use because aquatic invertebrates and other aquatic life have occurred and currently occur at the site. The lack of aquatic invertebrate, or periphyton field survey data prior to mining preclude making a determination about the quality and biodiversity of these populations prior to mining. Since the pre-mining fish were dependent on these lower trophic levels for survival, it can be assumed that they were present in adequate numbers and diversity to maintain pre-mining fish resources. The 1995 through 2005 post-mining field surveys have firmly established that growth and propagation of aquatic invertebrates, and periphyton are an existing and designated use.

c. *Aquatic Life Conclusions*

Resident and migratory fish and other aquatic life have acclimated to the natural cadmium concentrations. Current ambient cadmium concentrations are no higher than the pre-mining ambient cadmium concentrations. Therefore, because the cadmium concentrations in the mine's effluent are much lower than the pre-mining natural ambient cadmium concentrations, the growth and propagation of fish existing and designated use will be protected.

ADEC Findings

Based on the information in Attachments A-3 and A-4, ADEC has determined that the baseline water quality is representative of natural conditions in accordance with 18 AAC 70.990(41). The pre-mining water quality data set demonstrates that the natural condition is of lower quality than the applicable cadmium chronic aquatic life criterion. A method for determining the prevailing highest quality natural condition (5^{th} percentile) has been described above and used to develop the site specific criteria: total cadmium concentration of 2 µg/L in Ikalukrok Creek. This site specific criteria is more stringent than the narrative criteria that protect the industrial, contact recreation, and secondary recreation uses and will therefore protect these designated uses. This decision is consistent with the November 5, 1997 EPA policy on establishing site-specific aquatic life criteria equal to natural background, which states in part, "for aquatic life, where the natural background concentration for a specific parameter is documented, by definition that concentration is sufficient to support the level of aquatic life expected to occur naturally at the site absent any interference by humans." Therefore, the growth and propagation of fish, shellfish, other aquatic life, and wildlife use is protected.

Due to federal Anti-Backsliding regulations the effluent limits for cadmium in future NPDES Permits may be the same regardless of which NCBSSC is used in the calculation. The Department believes that using the cadmium NCBSSC for Ikalukrok Creek sets a precedent that is overly conservative when examining whether downstream uses are protected in setting NCBSSC. We believe that in this case using the NCBSSC for Main Stem Red Dog Creek is appropriate for the following reasons:

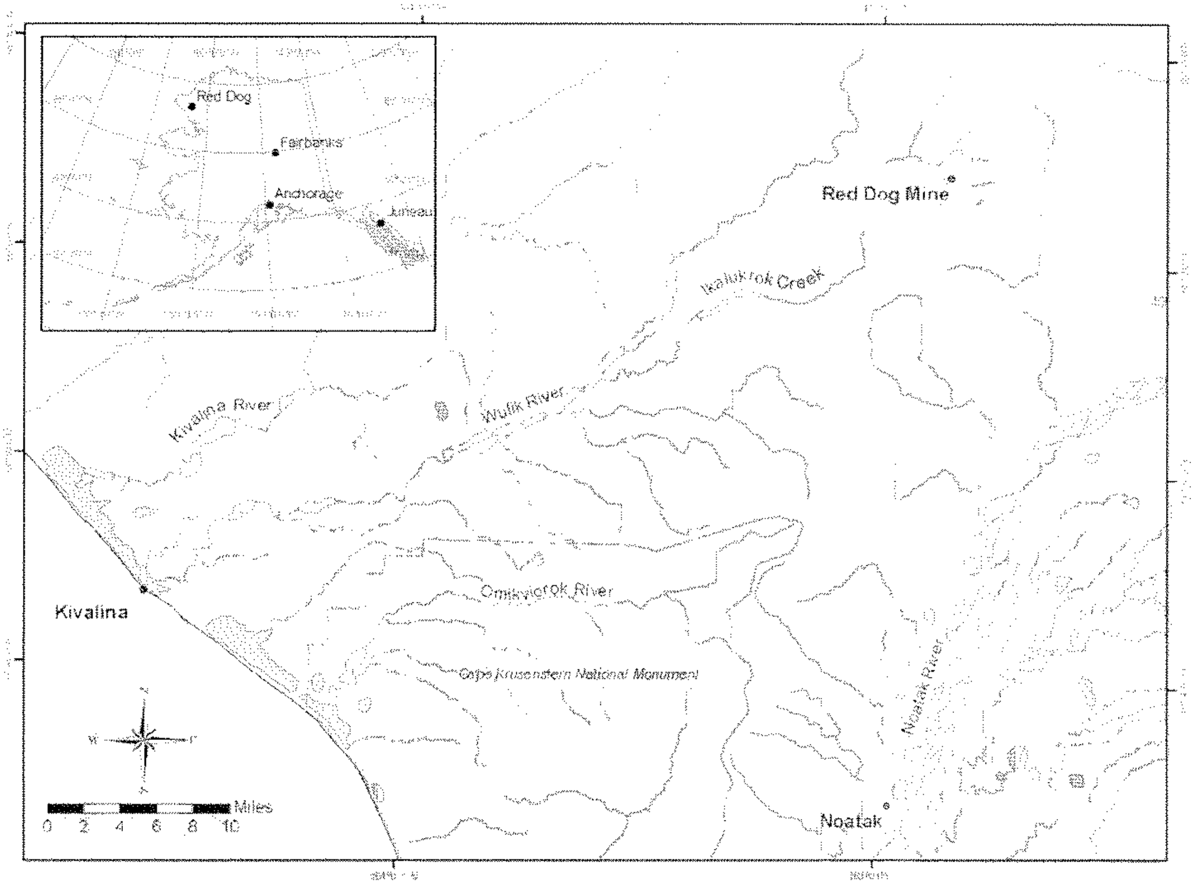
- Station 10 is located in Main Stem Red Dog Creek prior to its confluence with Ikalukrok Creek and best represents water quality nearest the effluent outfall where the aquatic life criteria apply.
- The mine facilities have been documented to cause a decrease in cadmium loading to Main Stem Red Dog Creek; therefore, applying the Main Stem Red Dog Creek NCBSSC to the effluent would ensure that the effluent is not contributing to cadmium concentrations above the natural condition downstream in Ikalukrok Creek. Applying the Main Stem Red Dog Creek NCBSSC would therefore protect downstream uses.
- The NCBSSC for Ikalukrok Creek is overly conservative due to the location of Station 8, which the NCBSSC is based on. Station 8 is located in Ikalukrok Creek just below the confluence with Main Stem Red Dog Creek. Station 8 does not represent well mixed water from the two creeks, but rather is located at a point where upstream Ikalukrok Creek water dominates. Since the Upper Ikalukrok Creek is generally of higher water quality than Main Stem Red Dog Creek, samples collected from Station 8 represent higher quality water than the actual mixed water of the two creeks.

The Department's position remains as stated earlier: that calculating NPDES Permit effluent limits based on the Ikalukrok Creek NCBSSC (2 µg/L), would be protective of existing and designated uses

and comply with 18 AAC 70. However, the Department believes that this approach is overly conservative and is not required by applicable State of Alaska regulations.

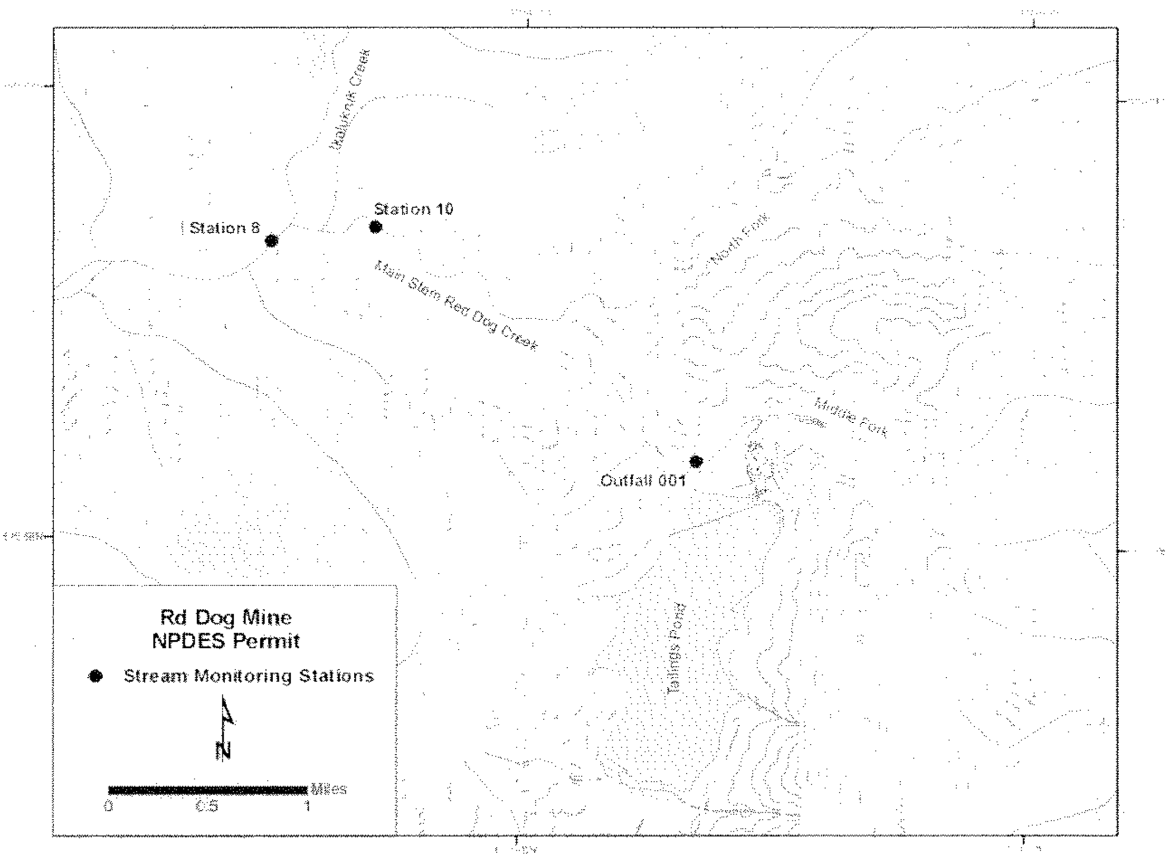
Attachment A-1

Location of Red Dog Mine Site



Attachment A-2

Location of Baseline Monitoring Stations in Mainstem Red Dog Creek and Ikalukrok Creek



Attachment A-3

Pre-Mining Dissolved Water Quality Data for Cadmium

Date	Station 10 Mainstem Red Dog Creek	Station 8 Ikalukrok Creek below Mainstem Red Dog Creek
6/17/81	22	
7/17/81	25	
7/18/81		10
8/11/81	26	7
9/4/81	38	8
5/30/82	2	
7/6/82	25	
7/8/82	23	14
7/14/82	27	
7/21/82	32	
7/22/82	35	
7/23/82	34	
7/23/82	40	
7/24/82	36	
7/26/82	<25 (12.5)	
7/29/82	27	
7/30/82	<25 (12.5)	
7/31/82	<25 (12.5)	
8/1/82	26	
8/12/82	34	
8/12/82	<25 (12.5)	
8/14/82	17	
9/13/82	34	19
10/19/82	41	34
6/15/83		2

Summary Statistics	Station 10	Station 8
Median	26	9
Maximum	41	34
Minimum	2	2
5th Percentile	**12.5**	**3.5**

* Cadmium data is expressed in micrograms/liter in the dissolved concentration

Attachment A-4

Pre-Mining Total Water Quality Data for Cadmium

Date	Station 10 Mainstem Red Dog Creek	Station 8 Ikalukrok Creek below Mainstem Red Dog Creek
5/30/1982	2	1
7/6/1982	26	
7/8/1982	24	16
7/14/1982	29	
7/21/1982	31	
7/22/1982	35	
7/23/1982	34	
7/23/1982	38	
7/24/1982	35	
7/26/1982		
7/29/1982	28	
7/30/1982	< 25	
7/31/1982	< 25	
8/1/1982	26	
8/7/1982	36	
8/12/1982	41	25
8/13/1982		
8/14/1982	20	
9/13/1982	38	20
10/19/1982	44	38
5/28/1983	9	4
6/14/1983		
6/15/1983	10	4
7/10/1983	29	7
8/3/1983	33	4
9/3/1983	34	14
6/9/1986		10
6/16/1986		< 2
6/23/1986		< 2
6/30/1986		< 2
7/7/1986		< 2
7/14/1986		10
7/21/1986		< 2
7/28/1986		< 2
6/1/1987		< 2
6/8/1987		4
6/16/1987		
6/22/1987		7
6/29/1987		8

7/7/1987		9
7/14/1987		< 2
7/20/1987		< 2
7/28/1987		13
8/3/1987		14
8/10/1987		7
8/17/1987		15

Summary Statistics	**Station 10**	**Station 8**
Median	29	7
Maximum	44	38
Minimum	2	1
5th percentile	**9**	**2**

* Cadmium data is expressed in micrograms/liter in the total concentration

APPENDIX C
Development of Effluent Limitations

This section discusses the basis for and the development of metals, pH, total dissolved solids, and total suspended solids limitations in the draft permit. The discussions include the development of technology-based effluent limitations (Section A.) and water quality-based effluents limitations (Section B.) and a summary of the effluent limitations developed for the draft permit.

I. Outfall 001

A. Technology-based Evaluation

Section 301(b) of the CWA requires technology-based controls on effluents. Red Dog Mine is considered a new source. The term "*new source*" means any source, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance under this section (Section 306 of the CWA) which will be applicable to such source, if such standard is thereafter promulgated in accordance with this section. On December 3, 1982, EPA published effluent guidelines for the mining industry which are found in 40 CFR Part 440. Within these guidelines, Subpart J of Part 440, titled *Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory*, applies to the mine discharges from Red Dog. The New Source Performance Standards (40 CFR 440.104) are used to provide the technology-based effluent limitations for copper, zinc, lead, mercury, cadmium, pH and TSS.

40 CFR 440.104(a) states that the concentration of pollutants discharged in mine drainage from mines that produce copper, lead, zinc, gold, silver or molybdenum bearing ores or any combination of these ores from open-pit or underground operations other than placer deposits shall not exceed the following concentrations:

Table C-1
Technology-based Effluent Limitation Guidelines

Parameter (in ug/L unless otherwise noted)	Average Daily	Daily Maximum
Copper	150	300
Zinc	750	1500
Lead	300	600
Mercury	1	2
Cadmium	50	100
TSS, mg/L	20	30
pH, standard units	Within the range of 6.0 to 9.0	

40 CFR 440.130(d)(1) allows for a pH adjustment above 9.0 where the application of neutralization and sedimentation technology to comply with relevant metal limitations results in an inability to comply with the pH range of 6 to 9. This is the case for Red Dog where metals precipitate out of solution better at higher pH. The current permit contained a pH range of 6.0 to 10.5 and EPA included this range in the draft permit.

40 CFR 440.104(b) states that there shall be no discharge of process wastewater to navigable waters from mills that use the froth-flotation process alone or in conjunction with other processes for the beneficiation of gold ore. In the event that the annual precipitation falling on the treatment facility and the drainage area contributing surface runoff to the treatment facility exceed the annual evaporation (net precipitation), a volume of water equal to the difference may be discharged subject to the limitations set forth in Table C-1, above.

The flow regime at Red Dog is complicated and difficult to understand. The information provided by TCAK (the annual discharge and precipitation numbers, below) lead to a conclusion that the level in the impoundment should be falling, not rising as has been the case in the last few years. The following table shows the actual discharge for each year, the actual precipitation and the calculated value of the net precipitation. The last column shows the difference between the actual discharge and calculated net precipitation.

Table C-2
Discharge and Net Precipitation

Year	Discharge (bgal/yr)	Precip (in)	Precip – Evap* ("Net Precip") (bgal/yr)	Difference between Net Precip & Discharge
1992	0.5	15.2	0.62	0.12
1993	0.2	19.7	0.82	0.62
1994	0.9	25.6	1.07	0.17
1995	1.9	14.8	0.6	-1.3
1996	1.7	16.9	0.7	-1
1997	1.1	16.2	0.67	-0.43
1998	1	20.5	0.85	-0.15
1999	1.5	11.8	0.47	-1.03
2000	1.2	21.7	0.91	-0.29
2001	1.4	19.3	0.8	-0.6
2002	1	20.7	0.86	-0.14
2003	1	19.3	0.8	-0.2
2004	1	20.3	0.85	-0.15
2005	1.5	15.3	0.63	-0.87
Total	15.9		10.65	-5.25

*Evaporation was determined to be 9 inches per year over a 200 acre tailings impoundment

Since 1992, the Table shows that 5.25 billion gallons more were discharged than can be accounted for by the net precipitation in the drainage area. Based on the provided precipitation and evaporation data this would seem to indicate that, even while there are other flow contributors to the tailings impoundment (these are listed earlier in this Fact Sheet) there is some flow into the impoundment that is unaccounted for in attempting to explain the rise in the water level in the impoundment. To give an idea of the scale of this discrepancy, discharging 5 billion excess gallons over 14 years is

equivalent to discharging over 1 million gallons of excess water per day, every day for all of those 14 years.

In the current permit, EPA and ADEC acknowledged that there was water in the water balance unaccounted for in the conventional measuring of the inflows and the outflows from the impoundment. Though the source is unknown, there doesn't appear to be any source of the water besides net precipitation or ground water infiltration, so EPA is proposing to retain the same effluent volume limit of 2.418 bgal/year as in the current permit. As a practical matter, the wastewater flow is dictated by the instream TDS requirements so the effluent volumes under the current permit remained far below the maximum allowable discharge.

B. Water Quality-based Evaluation

Section 301(b)(1)(C) of the CWA requires the development of limitations in permits necessary to meet water quality standards. Discharges to state waters must also comply with limitations imposed by the state as part of its certification of NPDES permits under section 401 of the CWA.

The NPDES regulation [40 CFR 122.44(d)(1)] implementing section 301(b)(1)(C) of the CWA requires that permits include limits for all pollutants or parameters which "are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality."

The regulations require that this evaluation be made using procedures which account for existing controls on point and non-point sources of pollution, the variability of the pollutant in the effluent, species sensitivity (for toxicity), and where appropriate, dilution in the receiving water. The limits must be stringent enough to ensure that water quality standards are met, and must be consistent with any available wasteload allocation.

When evaluating the effluent to determine if water quality-based effluent limits are needed based on chemical-specific numeric criteria, a projection of the effluent water concentration for each pollutant of concern is made. If a mixing zone is authorized, then the dilution would be considered. The chemical-specific concentration of the effluent and ambient water and, if appropriate, the dilution available from the ambient water are factors used to project the receiving water concentration. If the projected concentration of the effluent exceeds the numeric criterion for a specific chemical, then there is a reasonable potential that the discharge may cause or contribute to an excursion above the applicable water quality standard, and a water quality-based effluent limit is required.

The water quality parameters that may be affected by the discharge are metals, cyanide, pH, dissolved solids, and turbidity.

1. **Toxics - Metals and Cyanide**

Water quality-based effluent limitations for metals and cyanide were developed based upon guidance in EPA's Technical Support Document for Water Quality-based Toxics Control (TSD). The water quality-based analysis consists of four steps:

- Determine the appropriate water quality standard,
- Determine if there is "reasonable potential" for the discharge to exceed the standard in the receiving water,
- If there is "reasonable potential", develop a wasteload allocation (WLA), and a long term average (LTA), then
- Develop effluent limitations based on the LTA.

The following sections provide a detailed discussion of each step. Appendix D provides an example calculation to illustrate how these steps are implemented.

a. Water Quality Standards

The first step in developing water quality-based limitations is to determine the applicable water quality standard. For Alaska, the current State Water Quality Standards (WQS) are found in 18 AAC 70.020. The applicable standards are based on the designated uses of the receiving water, the Middle Fork Red Dog Creek, which is protected for the uses described in Section IV.B. of this Fact Sheet. The applicable water quality standards are used to calculate water quality-based effluent limitations. EPA has determined that the appropriate standards to use are those protecting for the downstream use of Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife (aquatic life standards).

Under the anti-backsliding provisions of the Act, any limits in a reissued permit must be at least as stringent as the current limits unless a change meets one of the exceptions listed in CWA § 402(o)(2) or in CWA § 303(d)(4)(B). These are listed below:

402(o)(2) EXCEPTIONS — A permit with respect to which paragraph (1) applies may be renewed, reissued, or modified to contain a less stringent effluent limitation applicable to a pollutant if —

> (A) material and substantial alterations or addition to the permitted facility occurred after permit issuance which justify the application of a less stringent effluent limitation;
>
> (B)(i) information is available which was not available at the time of permit issuance (other than revised regulations, guidance, or test methods) and which would have justified the application of a less stringent effluent limitation at the time of permit issuance; or

(ii) the Administrator determines that technical mistakes or mistaken interpretations of law were made in issuing the permit under subsection (a)(1)(B).

(C) a less stringent effluent limitation is necessary because of events over which the permittee has no control and for which there is no reasonably available remedy;

(D) the permittee has received a permit modification under section 301(c), 301(g), 301(h), 301(i), 301(k), 301(n), or 316(a); or

(E) the permittee has installed the treatment facilities required to meet the effluent limitations in the current permit and has properly operated and maintained the facilities but has nevertheless been unable to achieve the current effluent limitation, in which case the limitation in the reviewed, reissued, or modified permit may reflect the level of pollutant control actually achieved (but shall not be less stringent than required by effluent guidelines in effect at the time of permit renewal, reissuance, or modification).

303(d)(4) LIMITATIONS ON REVISION OF CERTAIN EFFLUENT LIMITATIONS —

(B) STANDARD ATTAINED — For waters identified under paragraph (1)(A) where the quality of such water equals or exceeds levels necessary to protect the designated use for such waters or otherwise required by applicable water quality standards, any effluent limitation based on a total maximum daily load or other waste load allocation established under this section, or any other permitting standards may be revised only if such revision is subject to and consistent with the antidegradation policy established under this section.

Some of the metals standards are hardness-based. In calculating these standards, an increase in hardness results in higher criteria. This is because at a higher hardness, these metals are less toxic. The current permit used a hardness of 260 mg/L $CaCO_3$ to calculate the effluent limitations. This hardness was calculated as the 5^{th}-percentile hardness of the receiving water at Station 10, the downstream edge of the mixing zone where aquatic life uses are to be protected. EPA believes this location is appropriate to determine the hardness level for use in the draft permit.

The standards are provided in Table C-3.

Table C-3 Water Quality Standards			
Parameter, (in ug/L unless noted otherwise)	Current Standards		Proposed Standards
	Acute	Chronic	
Aluminum	750	87	
Ammonia[2], mg/L	16.4	7	
Cadmium	5.63	0.55	2
Chromium, III	3943	188	
Chromium, VI	16	11	
Copper	34.4	21.1	
Cyanide[3]	22	5.2	
Iron	—	1000	
Lead	275.5	10.7	
Manganese	—	—	
Mercury	2.4	0.012	
Nickel	1053	117	
Selenium	20	5	
Silver	21	—	
Zinc		269[4]	
TDS[5]	Shall not exceed 500.		Shall not exceed 1000/1500.
TDS[6]	Shall not exceed 1500		

1 – Proposed Standards will be used in developing permit limits only if EPA approves the proposed standard prior to reissuance of the permit.

2 – Ammonia criteria are based on the pH and temperature data collected at Station 10 in the main stem of Red Dog Creek.

3 – The cyanide standards is free cyanide measured as weak acid dissociable (WAD).

4 - TCAK requested, in their application package, that EPA retain the SSC developed for zinc during the current permit issuance but in a letter to ADEC dated December 10, 2005, TCAK requested that ADEC not re-certify the SSC for zinc. The SSC was 210.

5 – This standard is applicable to the instream monitoring point that corresponds to the edge of the mixing zone in the Main Stem of Red Dog Creek at Station 151 during grayling spawning. See B.2. below for further information.

6 – This standard is applicable to the instream monitoring point that corresponds to the edge of the mixing zone in the Main Stem of Red Dog Creek at Station 151 after free flow is established but not during spawning unless the SSC for TDS is approved by EPA prior to the issuance of the final permit.

A permit must be issued using the WQS in effect at the time of issuance. Table C-3 also contains the WQS that ADEC has proposed. These standards may be adopted by ADEC and approved by EPA

before the Red Dog permit is finalized. Permit limitations have been calculated using the new standards as well as those currently in effect.

b. Reasonable Potential Evaluation

A reasonable potential analysis was performed to determine the need for limits. This analysis compares the maximum projected effluent concentration (C_e) to the criteria for that pollutant. If the projected effluent concentration exceeds the criteria, there is "reasonable potential" (RP) and a limit must be included in the permit. EPA uses the recommendations in Chapter 3 of the TSD to conduct this analysis.

The maximum projected effluent concentration (C_e) is defined by the TSD as the 99^{th} percentile of the effluent data. This is calculated by multiplying the maximum reported effluent concentration by a reasonable potential multiplier (RPM).

For parameters with technology-based effluent limitations guidelines, the maximum effluent concentration used to determine the RP is the technology-based maximum daily limitation. The technology-based limit is used since water quality-based limits are only required if discharges at the technology-based limits have the RP to exceed water quality standards in the receiving water. The RPM accounts for uncertainty in the effluent data and statistically depends upon the amount of effluent data and variability of the data as measured by the coefficient of variation (CV) of the data. The RPM decreases as the number of data points increases and the variability of the data decreases. If the maximum projected effluent concentration is greater than an applicable water quality standard then a water quality-based effluent limit is required.

Table C-4
Reasonable Potential Determination

Parameter (in ug/L unless otherwise noted)	Effluent Concentration	CV[1]	N= # of Samples	RPM	Maximum Projected Effluent Concentration	Reasonable Potential when compared with standards in Table C-2
Aluminum	210	1.5	77	2.27	476.7	Yes
Ammonia[2,4]	10.7	0.238	174	1.095	11.72	Yes
Cadmium[3]	100			1.0	100	Yes
Copper[3]	300			1.0	300	Yes
Cyanide[4]	6.9	0.614	131	1.332	9.2	No
Iron	<250	2.6	87	2.7	<675	No
Lead[3]	600			1.0	600	Yes
Lead[5]	3.6	0.5944	147	1.29	4.64	No
Mercury[3]	2			1.0	2	Yes
Nickel	51.9	1	144	1.47	76.5	No
Selenium	6.8	0.5	140	1.25	8.53	Yes
Silver	0.2	1.4	75	2.22	0.44	No
Zinc[3]	1500			1.0	1500	Yes

1 - CV is defined as the Standard Deviation ÷ the Mean of a data set.

2 - See Section 3.E., below.

3 - Metals with technology-based effluent guidelines.

4 - TCAK has requested mixing zones for these parameters. The effluent would be diluted to 40% at the edge of the requested mixing zone.

5 - Reasonable potential for lead if based only on water quality standards – see Appendix D.

c. Water Quality-Based Permit Limitation Derivation

Once EPA has determined that a water quality-based limitation is required for a parameter, the first step in developing the permit limitation is development of a Wasteload Allocation (WLA). A WLA is the concentration (or loading) of a pollutant that the permittee may discharge without causing or contributing to an exceedence of water quality standards in the receiving water. WLAs and permit limitations are derived based on guidance in the TSD. WLAs for this permit were established based on meeting aquatic life standards or site specific criteria at the end-of-pipe using the Alaska WQS.

The acute and chronic WLAs are then converted to long term average concentrations (LTAs) and compared. The most stringent LTA concentration for each parameter is statistically converted to effluent limitations. This section describes each of these steps.

Calculations of WLAs:

Where no mixing zone is allowed, the standard becomes the WLA. Establishing the standard as the WLA ensures that the permittee does not contribute to an exceedence of the standard.

ADEC has authorized a MZ for some parameters in their 401 Certification of the draft permit for TDS, WAD cyanide, and ammonia.

The NPDES regulations require that metals limits be expressed as total recoverable (TR) metals [40 CFR 122.45(c)]. This is because changes in water chemistry as the effluent and receiving water mix could cause some of the particulate metal in the effluent to dissolve and become bioavailable. Because the proposed WQS are expressed in dissolved, a translator is used in the WLA equation to convert the dissolved criteria to total recoverable. Since the State has not proposed translators in the recent revision to the WQS and there are no site-specific translators, the default translator is 1/CF where CF is the conversion factor in the WQS.

the WLA (TR) = the standard (diss) * the translator.

The standards are expressed as a total recoverable number or equation multiplied by a conversion factor (CF). Since the default translator is 1/CF, the equation becomes:

WLA (TR) = CF* standard (TR) * 1/CF
WLA (TR) = standard (TR).

Appendix D provides an example of how the WLAs for lead in Outfall 001 were developed.

Where there is only one standard specified, such as the site specific criteria for cadmium, it is used as the chronic WLA and the permit limitations are calculated as above except using just one LTA instead of the more stringent between an acute or a chronic LTA.

Appendix D shows an example of the permit limitation calculation for lead in Outfall 001.

2. **Total Dissolved Solids (TDS)**: TDS consists of inorganic salts and small amounts of organic matter dissolved in water. The principal constituents are: carbonates, chlorides, sulfates, potassium, magnesium, calcium, and sodium. TDS is typically introduced into surface waters by geologic formations underlying an area, groundwater (via seeps and springs into a freshwater system), wind-borne sea spray, and human activities (mining and other surface excavation, water treatment chemicals, road salting, residential and urban runoff, agricultural chemicals, and irrigation). The levels of TDS proposed in this permit reissuance are not designed to prevent adverse affects to aquatic life.

   The following summarizes the proposed effluent limitations that are in the draft permit for the facility:

   1. Effluent may be discharged so as to maintain the in-stream TDS concentrations at the approved site specific criteria (SSC) of 1500 mg/L at the edge of the mixing zone in Main Stem Red Dog (Station 151). The discharge may start after the free flow of water in the Main Stem Red Dog Creek begins and may continue at this level prior to grayling spawning which generally occurs several weeks later (when the water temperature at Station 151 reaches 3°C). If the SSC of 1500 mg/L for the grayling spawning period is approved, there would be no need to determine when spawning occurs since the criteria would be the same for both periods. If the SSC is not approved, the spawning period would be determined based on the temperature of the water at Station 151. The current permit contained provisions for approval by the Agencies to determine the beginning and the end of spawning. If necessary, these provisions will remain.

   2. If the SSC of 1500 mg/L is not approved prior to issuance of the permit and ADEC approves TCAK's December 17, 2005, request for an adjustment up to 1000 mg/L TDS as allowed under the WQS [18 AAC 70.020 Note 12], EPA will utilize 1000 mg/L during spawning periods. If the SSC is not approved and ADEC does not approve the adjustment up to 1000 mg/L, then EPA will utilize 500 mg/L in the permit during spawning.

   3. In Ikalukrok Creek, the effluent from the mine site must be regulated at the discharge point so that the TDS concentration outside the mixing zone (Station 150) in Ikalukrok Creek does not exceed 1000 mg/L.

4. When salmon and Dolly Varden are spawning in Ikalukrok Creek (July 25 through the end of the discharge season), effluent from the mine site must be regulated so that the TDS concentration in Ikalukrok Creek where spawning occurs does not exceed 500 mg/L (Station 160).

5. In the current permit, the end-of-pipe limit of 3900 mg/L was included for TDS. The primary reason for including this limit was to make assumptions that were being used to determine the flow that the facility could discharge and still remain in compliance with its in-stream limits. The limit of 3900 was not a water quality-based effluent limitation but the best professional judgment at the time the permit was modified. During this reissuance, EPA is removing this end-of-pipe limit from the permit based on new information showing that the control of flow is more of a determining factor in controlling the downstream concentration of TDS than is the TDS concentration in the effluent. EPA is replacing the 3900 in the equations with 110% of the highest measured effluent value. A review of the equations in Permit Part I.A.8.j. shows that this will be more conservative than relying on an absolute value of 3900 because the equations will assume higher effluent concentrations and therefore will not underestimate the downstream impact of the effluent.

   If the SSC during spawning is approved or the other proposed values are utilized in developing permit limits during spawning, less stringent limitations will appear in the permit. An exception to the anti-backsliding provision of the CWA is that a reissued permit may contain a higher limitation in light of new information [CWA § 401(o)(2)(B)(i)]. The studies that TCAK conducted contain new information specific to the site that was not available at the time the current permit limitations were imposed. As such, EPA is proposing to use the less stringent limitations.

3. **Turbidity:** The aquatic life standard for turbidity is that turbidity may not exceed 25 nephelometric turbidity units (NTU) above natural conditions. Natural condition, as defined in 18 AAC 70.990(42), means any physical, chemical, biological, or radiological condition existing in a waterbody before any human- caused influence on, discharge to, or addition of material to the waterbody.

   The highest value for turbidity that was found in the effluent was 2.1 NTU. It is not expected that the maximum projected effluent would reach 25 NTU so this parameter is not limited in the permit although monitoring will continue.

4. **pH**: The WQS require a pH range of 6.5 - 8.5 standard units for waters protected for contact recreation. In the 401 Certification, ADEC includes a justification for the limits of the current permit which were 6.5 – 10.5. EPA will include these limits in the draft permit.

5. **Ammonia:** The ammonia criteria are dependent on the pH and temperature of the receiving water. Since these two parameters can vary, EPA determined the pH and temperature based on data collected from 2001 – 2005 at the edge of the mixing zone, previously represented by Station 10. EPA calculated the 95^{th} percentile of the data set to determine the criteria to be applied (2.798 mg/L). EPA multiplied this criterion by the dilution factor (2.5) authorized by ADEC in the § 401 Certification to determine the effluent goal (7.0 mg/L). EPA then compares this goal to the maximum projected effluent value (11.72 mg/L). This value is calculated by multiplying the maximum effluent value (10.7 mg/L) by the reasonable potential multiplier (1.095). Since 11.72 mg/L is greater than 7.0 mg/L, there is reasonable potential for the effluent to exceed the standard and a limit is necessary.

   TCAK provided EPA with two Monte Carlo simulations (dynamic model). One simulation indicated that there is reasonable potential for ammonia to exceed the acute criterion. The other indicated that there was no reasonable potential for ammonia to exceed any criteria. EPA considered this additional information but determined that the additional complexity and did not provide added value to the analysis.

6. **Cyanide:** ADEC has proposed a mixing zone for cyanide with a dilution factor of 2.5. EPA determined the most stringent criteria to be applied (5.2 chronic). EPA multiplied this criterion by the dilution factor (2.5) to determine the effluent goal (13.0). EPA then compares this goal to the maximum projected effluent value (9.2). This value is calculated by multiplying the maximum effluent value (6.9) by the reasonable potential multiplier (1.332). Since 13.0 is greater than 9.2, there is no reasonable potential for the effluent to exceed the applicable criteria, and no limit is necessary. Monitoring shall remain in the permit on a weekly basis. Ambient monitoring for WAD cyanide has also been added to Station 151.

   ADEC has stated in its draft § 401 Certification that the use of a mixing zone for cyanide does not violate the State's Antidegradation Policy. The above analysis indicates that the effluent should not cause exceedences of the criteria at the edge of the mixing zone so it should be protective of the designated and existing uses downstream as required by 18 AAC 70.015(a)(1) Antidegradation Policy. As such, the permit may allow backsliding based on the CWA § 303(d)(4)(B) exception outlined above.

7. **Zinc:** The State has not re-certified the site specific criterion used for zinc in the current permit, which contained a zinc limit based on the natural condition site specific criteria provided in the State's 1998 § 401 Certification of the permit of 210 ug/L. This means that the state-wide criteria of 269 ug/L (both acute and chronic at a hardness of 260 mg/L $CaCO_3$) would be utilized to calculate the permit effluent limit. ADEC has determined that the use of this criteria would not violate their Antidegradation Policy. Also, EPA believes that the adoption by ADEC of the EPA Water Quality Criteria for Water [63 FR 68354-68364, December 10, 1998] for this parameter is protective of existing uses downstream of the outfall as required by 18 AAC 70.015(a)(1).

Antidegradation Policy, so the permit may allow backsliding based on the 303(d)(4)(B) exception outlined above.

8. **Whole Effluent Toxicity (WET):** In a document entitled, "WET Limit with Consideration to Updated Site-side Water Balance," TCAK requested a change to their WET limit based on a new water balance. This water balance eliminates the water of unknown origin from the calculation stating that all the flows into the tailings impoundment are proportional to precipitation. As such, the flow with the lowest assigned toxicity would be eliminated and the WET limits would be higher than those in the current permit.

   The discussion in Part I. of this Appendix on flow indicates that there seem to be inflows to the impoundment not accounted for in the water balance. This supports the inclusion of the water of unknown origin in the determination of the WET limit.

   The WET limits will remain the same as the current permit because (1) the existing limit is based on the natural background, (2) the natural background was based on a calculation of the natural condition, and (3) the water balance indicates that there is water of unknown origin entering the impoundment.

9. Fecal Coliform: For discharges to Red Dog Creek, the most protective applicable standard for fecal coliform is for Water Recreation - Secondary. 18 AAC 70.020(b)(2)(B)(ii) states, "In a 30-day period, the geometric mean may not exceed 200 FC/100 ml, and not more than 10% of the total samples may exceed 400 FC/100 ml." An average of 200 FC/100ml and a maximum of 400 FC/100ml are included as limits in the draft permit – the same as the current permit.

C. Summary of Draft Permit Effluent Limitations – Outfall 001

As discussed in Section V.A. of the fact sheet, the draft permit contains the more stringent of technology and water quality-based effluent limitations. The water quality-based limits are more stringent than the technology-based limits for the metals and have therefore been included in the permit. The draft permit contains those limits based on the latest version of the EPA-approved WQS. EPA believes that the adoption by ADEC of the EPA Water Quality Criteria for Water [63 FR 68354-68364, December 10, 1998] for these parameters is protective of existing uses downstream of the outfall as required by 18 AAC 70.015(a)(1) Antidegradation Policy so the permit may allow backsliding based on the 303(d)(4)(B) exception outlined above.

Table C-5 shows a comparison between the technology-based and water quality-based effluent limitations and which limitations are in the draft permit.

Table C-5
Draft Permit Effluent Limitations

Parameter[1]	Technology-based		WQ-based		Draft Permit Limits	
	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly

Table C-5
Draft Permit Effluent Limitations

Parameter[1]	Technology-based		WQ-based		Draft Permit Limits	
	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly
Aluminum	-	-	159.35	55.20	159.35	55.20
Ammonia, mg/L N	-	-	10.64	6.80	10.64	6.80
Cadmium[2]	100	50	0.94	0.44	0.94	0.44
Cadmium[3]	100	50	6.30	2.95	3.4	2.0
Copper[2]	300	150	34.40	17.15	34.4	17.1
Cyanide, WAD	-	-	-	-	-	-
Lead[2]	600	300	17.53	8.78	17.53	8.78
Mercury	2	1	0.02	0.01	0.02	0.01
Selenium	-	-	7.80	4.23	7.8	4.2
Zinc	1500	750	386.32	237.11	386.32	237.11
TSS, mg/L	30	20	-	-	30	20
pH, S.U.	6.0 to 9.0[4]		6.5 to 10.5		6.5 to 10.5	
WET, TU_c	-		12.2	9.7	12.2	9.7

1 - Units are ug/L unless otherwise noted.
2 - Hardness based metals criteria used a hardness of 260 mg/L $CaCO_3$
3 - These are the cadmium limits which would be used if the proposed SSC were to be approved by EPA prior to permit issuance.
4 - The Effluent Limitation Guidelines allow this to exceed 9 in certain circumstances, see Fact Sheet Appendix C Part I.

II. Outfall 002 - Domestic Wastewater Discharge

A. Technology-based limitations

Secondary Treatment [18 AAC 72.040 and 18 AAC 72.990(64)]

Biological Oxygen Demand (BOD_5): The regulations for secondary treatment require that BOD meet a 7 day average of 45 mg/L, a 30 day average of 30 mg/L and the arithmetic mean of the values for effluent samples collected in a 24-hour period does not exceed 60 mg/L.

Total Suspended Solids (TSS): The regulations for secondary treatment require that TSS meet a 7 day average of 45 mg/L, a 30 day average of 30 mg/L and the arithmetic mean of the values for effluent samples collected in a 24-hour period does not exceed 60 mg/L.

pH: pH levels be maintained between 6 and 9 standard units.

B. Water Quality-Based limitations

The receiving waters under this permit are protected for all uses. The most protective criteria will be used in the Permit.

Fecal Coliform: For freshwater, the most protective standard for fecal coliform is for drinking, culinary and food processing use since no uses have been

removed from the tundra wetlands. 18 AAC 70.020(b)(2)(A)(i) states, "In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than one sample, or more than 10% of the samples may exceed 40 FC/100 ml." An average of 20 FC/100ml and a maximum of 40 FC/100ml are included as limits in the draft permit.

Chlorine: The WQS contain aquatic life criteria for acute (19 ug/L) and chronic (11 ug/L). EPA used the process outlined in Section I. above, utilizing 0.6 as the CV. The permit limits for chlorine would be an average of 9.01 ug/L and a maximum of 18.07 ug/L.

If chlorine (Cl) is used for disinfection, the compliance evaluation level will be 0.1 mg/L as a daily maximum. The effluent limit for chlorine is not quantifiable using EPA approved analytical methods. The ML for EPA Methods 330.3 and 330.4 is 0.1 mg/L and is used as the compliance evaluation level for this parameter.

pH: For fresh waters, the most protective limitations on pH are for aquaculture and contact recreation. This level is 6.5 to 8.5 standard units.

Dissolved Oxygen: The WQS require a minimum concentration of 7 mg/l for dissolved oxygen for discharges to fresh water. The maximum concentration for dissolved oxygen is 17 mg/l. A minimum of 7 mg/L and a maximum of 17 mg/L are included as effluent limits in the draft permit.

APPENDIX D - Example Water Quality-based Effluent Limitation Calculation

This appendix demonstrates how the water quality-based analysis (reasonable potential determination and development of effluent limitations was performed using cadmium in Outfall 001 as an example. Because of the proposed changes to the WQS, the calculations are shown for the current standards as well as the proposed.

Step 1: *Determine the applicable water quality standard.*

The current Alaska water quality standards for lead are provided below at a hardness value of 260 mg/L $CaCO_3$.

Table D-1 Lead criteria

Parameter	Acute standard	Chronic standard
Lead, ug/L	275.5	10.7
* these standards are already translated from the proposed dissolved standard to a total recoverable standard		

Step 2: *Determine if there is reasonable potential for the discharge to exceed the standard.*

To determine reasonable potential, the maximum projected effluent concentration, when no mixing zone is authorized, is compared to the applicable water quality standards. If this exceeds the standard, then a reasonable potential exists and a water quality-based effluent limit is established.

Since lead is a technology-based effluent limit, the following equation applies:

300 * RPM (reasonable potential multiplier) = 300 * 1 = 300

If this had been based on a water quality-based limit, the statistics discussed in the previous Appendix would have been applied to determine the RPM:

The tables in the TSD used to determine reasonable potential multipliers are not broad enough for parameters with more than 20 data points. EPA utilized the equations on page 52 of the TSD to determine the multiplier for lead. The maximum effluent measure for lead was 3.6 ug/L, the CV is 0.64, the number of effluent samples is 147 and the RPM is 1.29. The maximum projected effluent value for lead would be 4.64 ug/L and is less than the chronic criteria of 10.7 ug/L. So if the RP was determine strictly on a WQ basis, there would be no reasonable potential for lead to violate the criteria.

The effluent from outfall 001 has the reasonable potential to exceed the lead aquatic life standard based on the analysis of the technology-based limitation. Therefore, water quality-based limitations are required.

Step 3: *Determine the wasteload allocation.*

The wasteload allocations (WLAs) for lead are equal to the standards:

	WLA
Acute	275.5
Chronic	10.7

Step 4: *Develop long-term average (LTA) concentrations.*

Effluent limitations are developed by converting the aquatic WLAs to LTAs. The most stringent of the acute or chronic LTA is then used to develop the effluent limitations.

$$LTA = WLA * \exp[0.5\sigma^2 - z\sigma]$$

where,
z = 2.326 for 99th percentile probability basis (per the TSD)
CV = 0.59
For acute: $\sigma^2 = \ln(CV^2 + 1) = \ln[(0.59*0.59) +1] = 0.2987$ $\sigma = 0.5465$
For chronic: $\sigma^2 = \ln(CV^2/4 + 1) = \ln[(0.59*0.59/4) +1] = 0.0834$ $\sigma = 0.2889$

LTA	
Acute	89.16
Chronic	5.67

The most stringent LTA concentration will be used to derive the effluent limitations for lead. In this case, the chronic LTA is used.

Step 5: *Develop effluent limitations*

The LTA concentration is converted to a maximum daily limit (MDL) and an average monthly limit (AML).

$$MDL, AML = LTA * \exp[z\sigma - 0.5\,\sigma^2]$$

where, for the MDL:
z = 2.326 for 99th percentile probability basis (per the TSD)
$\sigma^2 = \ln(CV^2 + 1) = \ln[(0.64*0.64) +1] = 0.3433$

for the AML:
z = 1.645 for the 95th percentile probability basis (per the TSD)
$\sigma^2 = \ln(CV^2/n + 1) = \ln[(0.64*0.64/4) +1] = 0.0975$
since n = number of samples per month = 4
(4 is the minimum recommended by the TSD)

MDL $= 5.4 * \exp[z\sigma - 0.5\,\sigma^2] = 5.4 * \exp[2.326*0.5859 - 0.5*0.3433] = 17.53$

AML $= 5.4 * \exp[z\sigma - 0.5\,\sigma^2] = 5.4 * \exp[1.645*0.3122 - 0.5*0.0975] = 8.78$

MDL = 17.53 ug/L
AML = 8.78 ug/L